SOFIA Project

SOFIA – Stratospheric Observatory for Infrared Astronomy

Code R/RAF Cranwell Brief
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National Aeronautics and Space Administration
Dryden Flight Research Center

SOFIA Member Organizations

SOFIA Stratospheric Observatory for Infrared Astronomy

- Team:
  - NASA (DFRC & ARC)
  - DLR (Deutsches Zentrum Fur Luft- and Raumfahrt)
  - USRA (Universities Research Space Assoc.)
  - L3 Com
  - MPC

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Aircraft Information

SOFIA Stratospheric Observatory for Infrared Astronomy

- Aircraft: Modified Boeing 747-SP
- Modifications:
  - Telescope Cavity In the Aft Section
  - Cavity Door on Left Aft Fuselage
    - URD (Upper Rigid Door)
    - LFD (Lower Flex Door)
    - AA (Aperature Assembly)
  - Infrared Telescope Assembly (2.7 Meter Telescope)
    - Working wavelength range: 0.3 μm to 1.6 mm
  - Mission Systems (Mission Controls)

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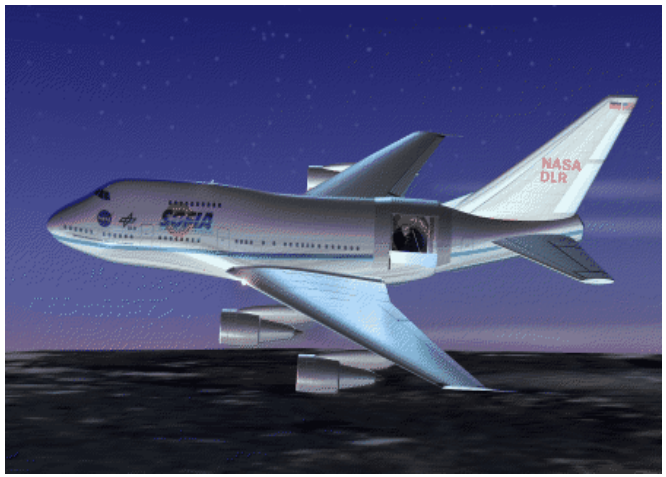
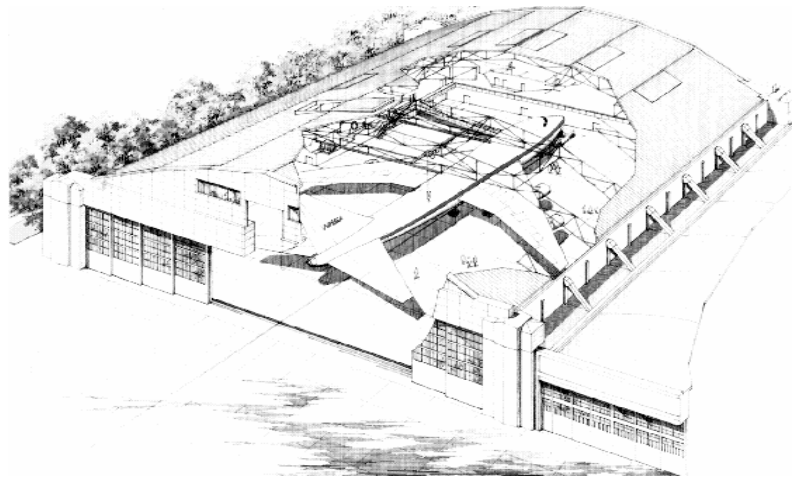
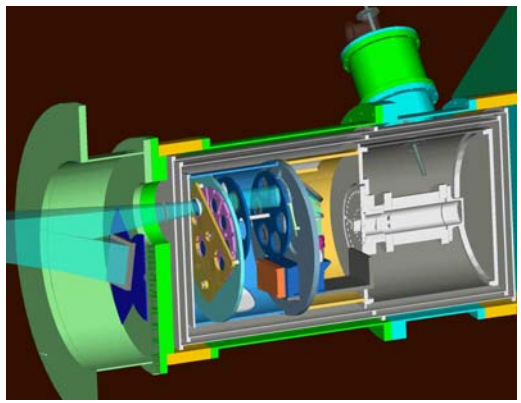
Major Components of SOFIA

SOFIA Stratospheric Observatory for Infrared Astronomy

Observatory







Science Instruments

Science and Mission Operations Center

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Aircraft External View

SOFIA Stratospheric Observatory for Infrared Astronomy

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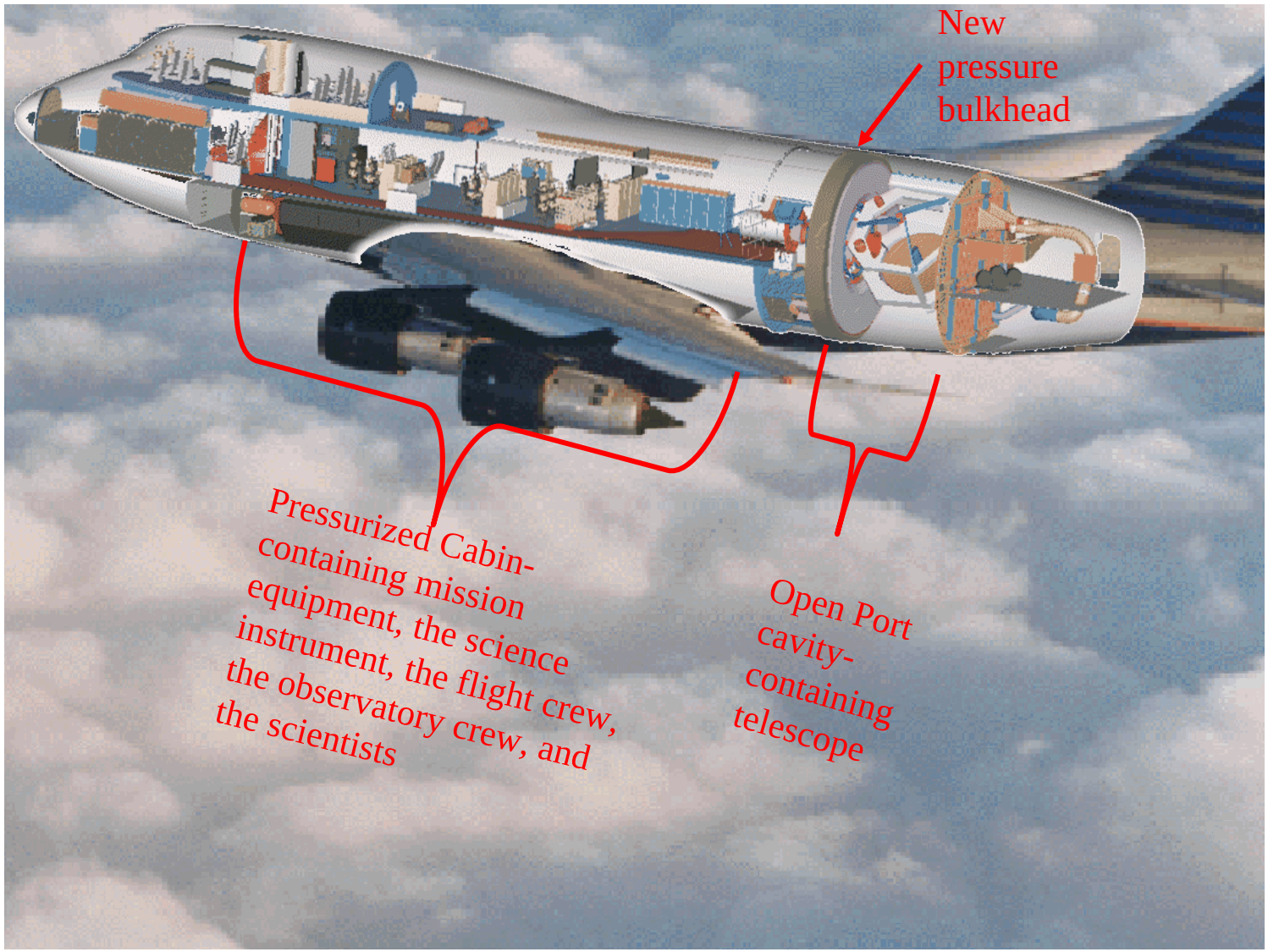
Airborne Observatory Layout

SOFIA Stratospheric Observatory for Infrared Astronomy



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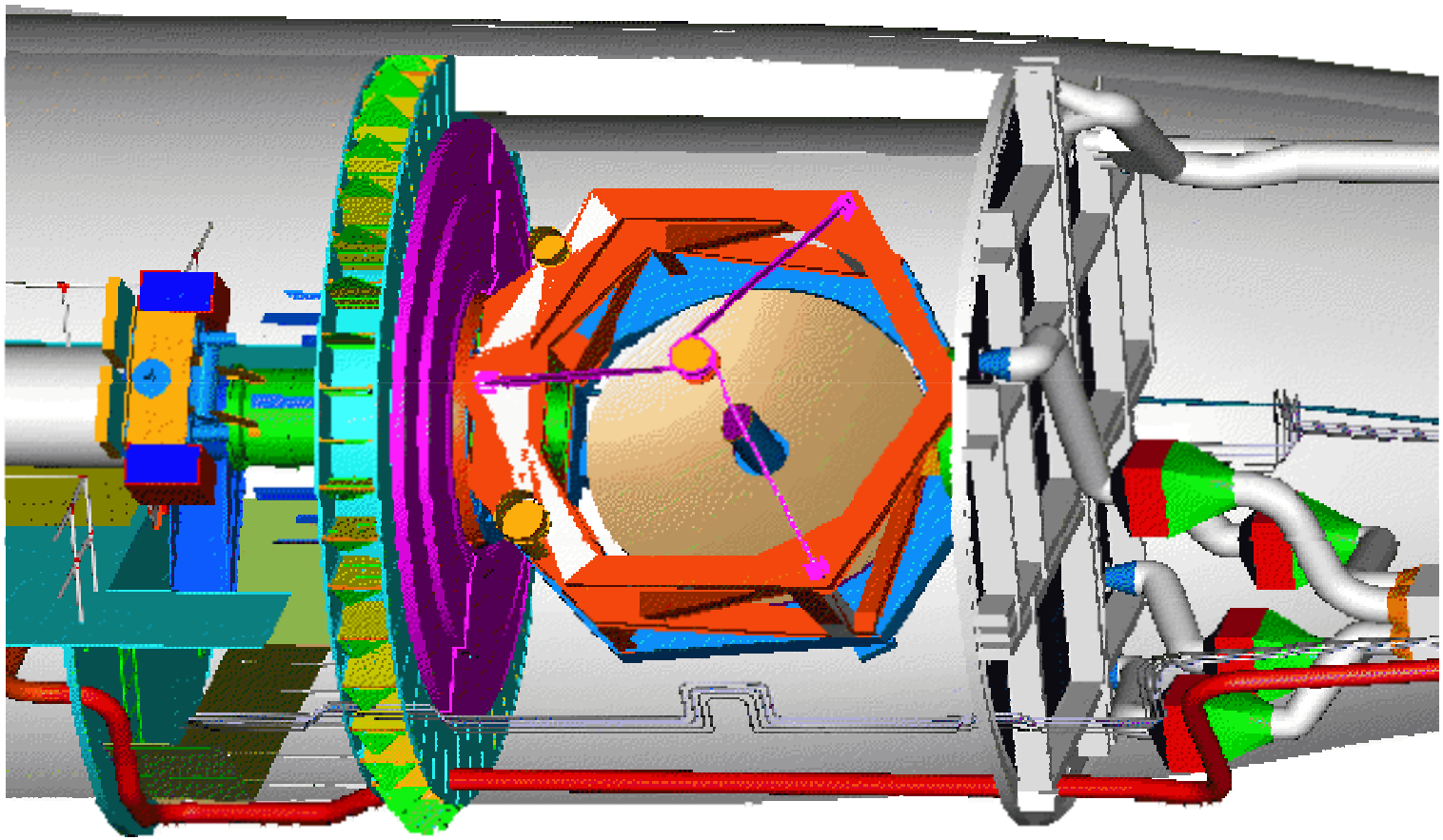
Telescope Assembly

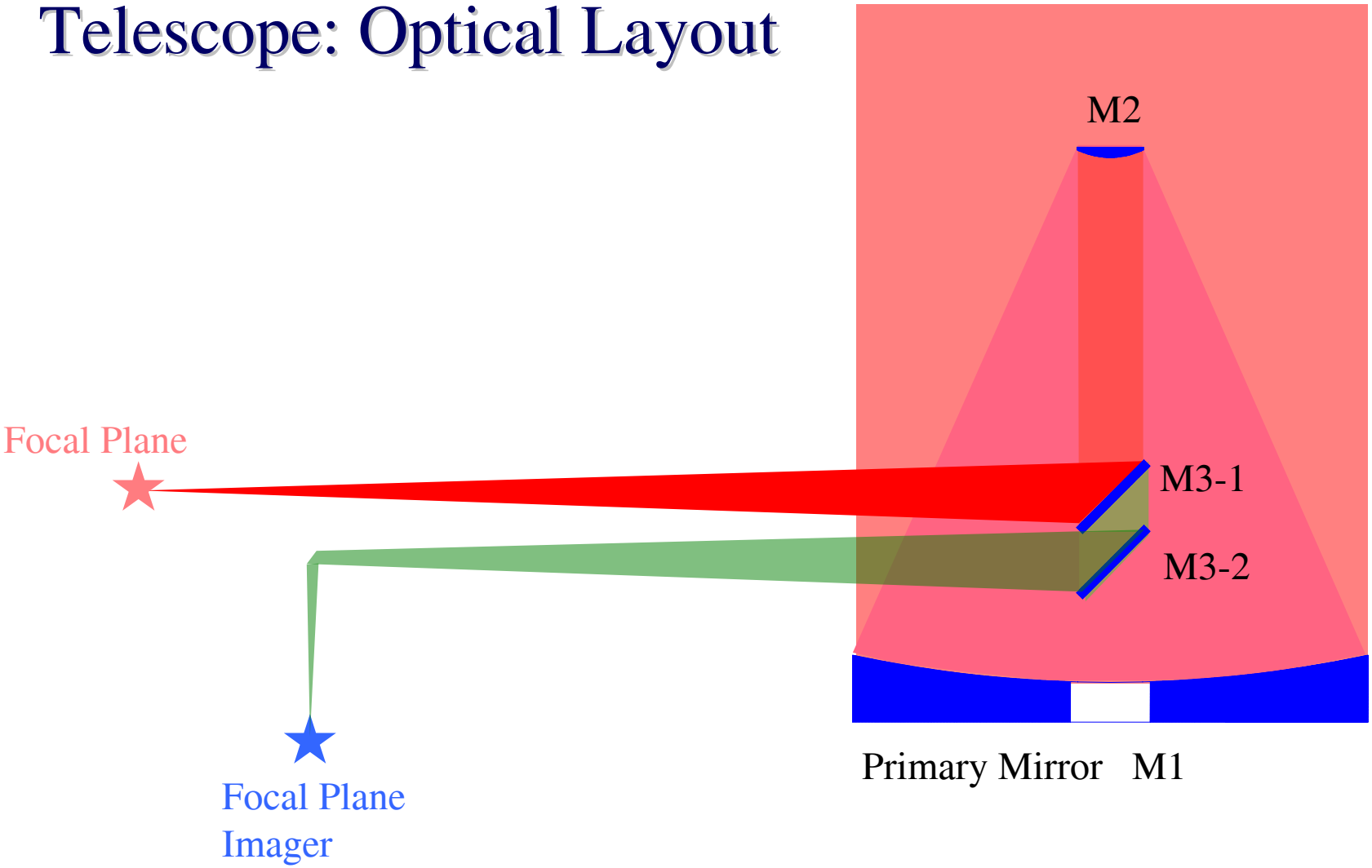
SOFIA Stratospheric Observatory for Infrared Astronomy



Telescope Assembly

SOFIA Stratospheric Observatory for Infrared Astronomy

Telescope: Optical Layout



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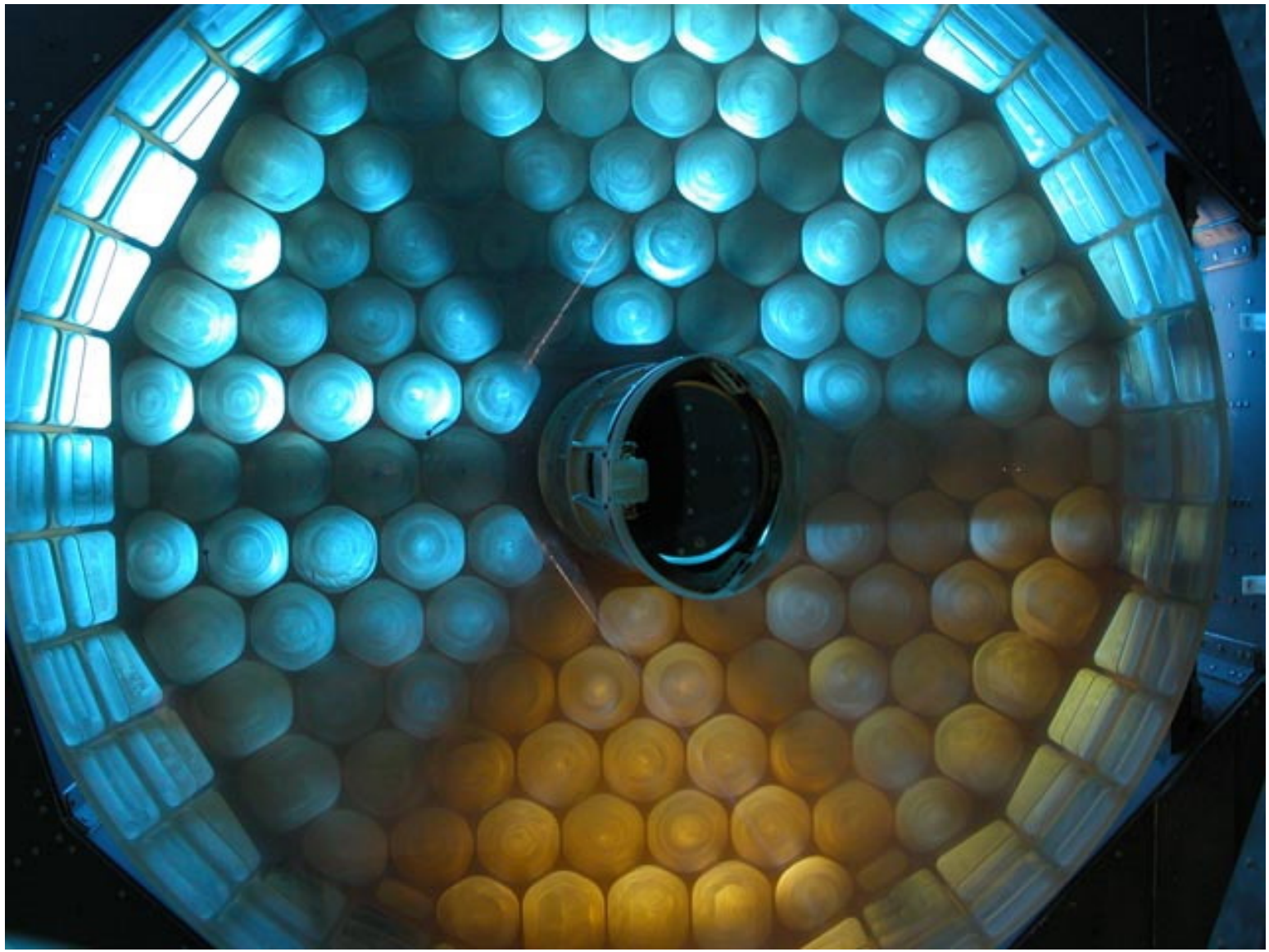
Uncoated Primary Mirror

SOFIA Stratospheric Observatory for Infrared Astronomy



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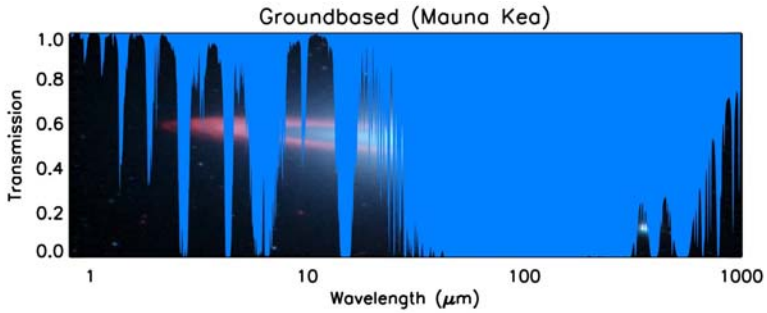
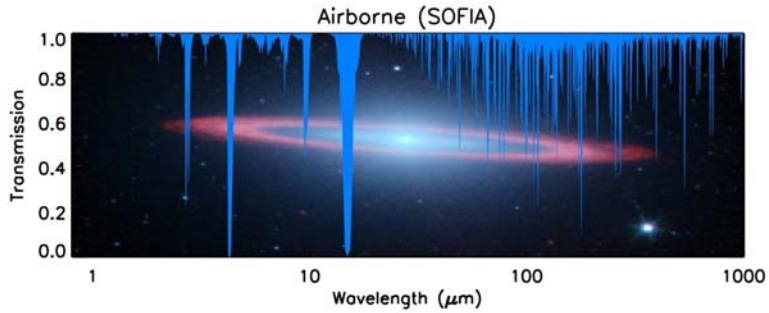
Airborne Astronomy

SOFIA Stratospheric Observatory for Infrared Astronomy





- SOFIA will operate above the tropopause - above 99.9% of the water vapor in the atmosphere - thereby opening up the IR universe
- SOFIA is a near-space observatory that comes home after every flight and coupled with a long life time this enables:
  - Wide instrument complement and fast change out
  - Larger and more complex instrumentation than space-based platforms
  - Rapid instrument upgrades
  - Rapid incorporation of new, cutting-edge technology
  - Test bed for future space instrumentation
  - Training ground for young experimentalists

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Requirements & Specifications

SOFIA Stratospheric Observatory for Infrared Astronomy

- Wavelength Range 0.3 - 1600 microns
- Unvignetted elevation range 20° to 60° above the horizon
- Configuration: Instrument Access in Cabin
- Telescope effective Aperture Diameter 2.5 meters
- Time at ≥ 41,000 feet ≥ 6 hours
- Observing hours per year ≥ 960
- Lifetime≥ 20 years
- IR functional capabilities: chopping, nodding, & scanning
- Image quality 80% encircled energy within 1.5 arcsec at visible wavelength
- Image stability at focal plane 0.2 arcsec rms

Combined to 80% encircled energy within 5.3 arcsec diameter image size at First Science Flight improving to 1.6 arcsec within 3 additional years.

Technical Challenges

SOFIA Stratospheric Observatory for Infrared Astronomy

- Open Port cavity
  - Influence on aircraft Stability & Control
  - Acoustic Issues
    - Resonance
    - Structural Fatigue
    - Environment for Telescope Performance
  - Drag (aircraft performance)
- Structural Modification
  - Strength
  - Stiffness
  - Transition to unmodified areas

Technical Challenges

SOFIA Stratospheric Observatory for Infrared Astronomy

- Thermal Environment
  - Systems exposure
  - Science performance
- Cavity Door
  - Accommodate fuselage deformation
  - Track Telescope motion
  - Drive system safety
- Lightweight Primary Mirror
- Rotational Isolation System

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Observatory Operation

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SOFIA Flight Test

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- Functional Check Flight and Ferry Flight to Dryden
- Closed Door Flight Test
- Open Door Flight Test
- Initial Operational Capabilities Flight Test
- Final Operational Capabilities Flight Test